

created that presents a basic point-minutia pattern layout to the scanner. Third, a scanner's capture resolution is evaluated or validated by creating a test pattern that allows for the verification of a scanner's capture resolution.

[0036] The goal of such a system is the design basis for evaluating a biometric capture device that captures fingerprint features without contact between the subject and the biometric scanner. The device must also generate images

example, aluminum, steel, various types of plastics and polymers, titanium, graphite, and glass. Aluminum is a material that can be machined, etched or ablated, and is mechanically stable at expected usage temperatures. Aluminum is typically available in standardized alloys with published compositions that provide for repeatability of design. The device can be constructed using typically two alloys of aluminum, 6020 and 6061, as displayed in Table 1 below.

Alloy Composition (all values in %, with balance of 100% being Aluminum)										
Alloy Name	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Pb	Sn
6020	0.4-0.9	0.5	0.3-0.9	0.35	0.6-1.2	0.15	0.2	0.15	0.05	0.9-1.5
6061	0.4-0.8	0.7	0.15-0.4	0.15	0.8-1.2	0.04-0.35	0.25	0.15		

from captures that are of a minimally acceptable forensic quality for effective identification and verification purposes and to ensure interoperability with legacy systems and devices. Certification and standards for fingerprint scanners in the United States require some sort of calibration target of known properties that can be imaged by the scanning device being tested. The resulting capture from the known target can then be examined as an image for fidelity to the original sample, consistency, and compliance with the requirements.

[0037] Similar to geometric features captured by traditional contact-based fingerprint scanners, a reference calibration target with known 3D geometric features can be created for use in contactless scanners. The target is presented to the contactless scanner for the scanner to scan and capture the geometric features of the target. Images or surface plots can then be created from the data captured. Given known or predefined feature geometry, the resulting images or surface plots can then be used to gauge the fidelity of the scanner to the original presented target. Such a target also provides a basis for comparison between different contactless scanners. The targets are intended for use, in part, for type calibration, whereby a particular scanning device model or system can be validated for proper operation by type calibration testing using the target. This testing is useful for model/system evaluation. Other like devices from a particular model/lot or system would normally not require testing for a representative model evaluation. To test for confirming repeatability or for quality control in manufacturing, however, more than one of a particular model would normally be tested.

[0038] In order to build a reference target (i.e., calibration target, or target) suitable for the task at hand, the following key criteria can be utilized:

[0039] Mechanical Stability: The target should be able to retain its shape after manufacturing and be able to withstand typical handling stress.

[0040] Thermal Stability: The target should be able to maintain its structural and optical characteristics throughout a reasonable temperature range.

[0041] Optical and Structural Contrast: The target should be able to provide some optical contrast as well as three-dimensional structural features to mimic surface features of a fingerprint.

[0042] Reproducible: The target should be reproducible with a reasonably acceptable level of effort and automated fashion.

[0043] Several types of materials available can be utilized to construct the target. These types of materials include, for

[0044] The scanner device should be able to maintain its structural and optical characteristics under a controlled ambient temperature range of $23^{\circ}\pm 2^{\circ}$ C. ($73\pm 3.6^{\circ}$ F.). The selection of Aluminum provides many benefits such as low cost and machinability, the coefficient of thermal expansion (α) for Aluminum is higher than most other materials. Given $\alpha=22.2\times 10^{-6}/^{\circ}\text{C}$ with a pattern area (L) of 16 mm, change in the position of features on the surface of the target can be quantified as for a 2° C. change in temperature using the equation:

$$\Delta r = \alpha_r \Delta T \text{ and } \Delta h = \alpha_h \Delta T$$

[0045] Given the equation above, Δr and Δh is calculated to be 22.2 micrometers per meter per degree of temperature change in length and radius of the cylinder, or 44.4 micrometers per meter at the maximum and minimum values of the test temperature range. Given the dimensions of sample test target, a radius of 9.547 mm was measured, resulting in a circumference 59.9855 mm. The change in radius due to a 2° C. rise or fall from 23° C. will respectively expand the cylinder to 59.9882 mm or contract it to 59.9829 mm. Changes due to thermal variance in the specified range are expected to be temporary and transient, and will not result in any permanent physical change in the target or adversely affect geometric features manufactured into the target for or during scanner testing.

[0046] The target should be able to provide some optical contrast as well as 3D structural features to mimic surface features in the fingerprinting area of a real finger. The selection of aluminum as the subject material allows for both the machining of surface features onto the medium to create 3D surface contrast and for anodization to enable the generation of optical contrast.

[0047] FIG. 4 illustrates an exemplary pictorial illustration of exemplary test patterns, in accordance with the disclosed embodiments. The typical characteristics used for state-of-industry application of fingerprints for identification and verification include the ridge structure of a finger, including where ridges begin or end, and bifurcations in the ridge structure. While it is possible to mimic a human ridge structure on a target for the verification of anthropometric fidelity, it is easier to quantify the ability of a device to capture certain features using basic primitive geometric patterns and constructs. A set of three test patterns was created: a dot (simulated "minutiae") pattern **401**, a grid (simulated "ridge") pattern **402**, and a resolution pattern **403**, as illustrated in FIG. 4.